CHAPTER 03700: POST-CONSTRUCTION STORMWATER QUALITY MANAGEMENT

SECTION 03701 INTRODUCTION

03701.01 Purpose and Background

It is recognized that developed areas, as compared to undeveloped areas, generally have increased imperviousness, decreased infiltration rates, increased runoff rates, and increased concentrations of pollutants such as fertilizers, herbicides, greases, oil, salts and other pollutants. As new development and re-development continues within the corporate boundaries of the City of Westfield, measures must be taken to intercept and filter pollutants from stormwater runoff prior to reaching regional creeks, streams, and rivers. Through the use of appropriate Best Management Practices (BMPs), stormwater runoff will be filtered and harmful amounts of sediment, nutrients, and contaminants will be removed.

It is also recognized that another major source of pollution in many Indiana streams, including those within the corporate boundaries of the City of Westfield, is the streambank erosion associated with urbanizing watersheds. Stream channels develop their shape in response to the volume and rate of runoff that they receive from their contributing watersheds. Research has shown that in hydrologically stable watersheds, the stream flow responsible for most of the shaping of the channel (called the bankfull flow) occurs between every one to two years. When land is developed, the volume and rate of runoff from that land increases for these comparatively small flooding events that are not normally addressed by the detention practices and the stream channel will adapt by changing its shape. As the stream channel works to reach a new stable shape, excess erosion occurs. As new development and re-development continues within the corporate boundaries of the City of Westfield, measures must be taken to minimize the impact of such development or re-development on streambank erosion. Through the use of appropriate BMPs, the volume and rate of runoff for channel-forming flows will be reduced in an attempt to minimize increased streambank erosion in the receiving streams and channels.

This Chapter describes measures that need to be taken to satisfy the Westfield Public Works Department (WPWD) Post-Construction Stormwater Management requirements, including Channel Protection and pollutant removal requirements.

03701.02 Abbreviations and Definitions

BMP: Best management practices can refer to structural measures (wetlands, ponds, sand filters, etc.) or non-structural measures (restrictive zoning, reduced impervious areas, etc.). BMPs are designed for the benefit of water quality and quantity. For the purposes of this chapter, BMPs refer to structural water quality BMPs, but in some circumstances, may include public education in cases where structural BMPs are not appropriate.

BMP owner: The owner of the BMP, typically the property owner. The BMP owner may also be the leasee of property in the case of long term leases of commercial or industrial zoned properties. The leasee is considered the BMP owner only if the lease specifically states that construction by the leasee must meet applicable local codes and regulations.

BOD:	Biochemical oxygen demand.
Contributing drainage area:	Contributing drainage area refers to the total drainage area to a given point, including offsite drainage.
Effective Drainage Area:	Effective drainage area refers to the drainage area from a specific site, excluding offsite drainage, where offsite drainage either does not exist or where offsite drainage bypasses the site through culverts or other means.
Floating Debris (Floatables):	Any solid waste that, due to its physical properties, will float on the surface of water. For the purpose of this manual, the term does not include naturally occurring floatables such as leaves or tree limbs.
Impervious Area:	Impervious areas are areas where the land surface has been altered to decrease the amount of rainwater infiltration. Impervious surfaces include paved roads, concrete driveways and rooftops.
Low Impact Development:	LID is a land planning and engineering design approach with a goal of replicating the pre-development hydrologic regime of urban and developing watersheds. The primary goal of LID is to mimic a site's predevelopment hydrology by reducing the impervious surface, infiltrating, filtering, storing, evaporating, and detaining runoff close to its source.
Offline structure:	Offline structures are BMPs that treat only the water quality volume (WQv). Flows exceeding the WQv bypass the structure and re-enter the watercourse below the BMP.
Redevelopment:	Redevelopment means any construction, alteration, or improvement where structures are removed and/or replaced. Where the disturbance caused by redevelopment activities disturbs less than 0.5 acres, no water quality BMP plan shall be required. Staff has the discretion to exempt redevelopment activities disturbing up to 5% more area.
Stormwater Quality Management:	A system of vegetative, structural, and other measures that reduce or eliminate pollutants that might otherwise be carried by surface runoff.
Total P:	Total phosphorus.
Total N:	Total nitrogen.
TSS:	Total suspended solids.

Treatment train: A treatment train consists of more than one BMP in series treating stormwater runoff. Such configurations are necessary when BMPs individually cannot meet the TSS reduction goal stated in the Ordinance.

Watershed: Watershed refers to the total drainage area contributing runoff to a single point.

SECTION 03702 BASIC POLICIES AND PROCEDURES

03702.01 Policy on Post-Construction Stormwater Quality Management

The City of Westfield has determined that to prevent degradation of water quality in streams within its jurisdiction, measures must be taken to minimize the conveyance of pollutants to the receiving stream and to ensure that the channel banks of receiving streams are not subject to increased erosion as a result of development. Channel protection is typically achieved by matching the post-construction runoff volume and rate to the pre-settlement (prior to any historical land conversion by man) condition for all runoff events up to the bankfull flow. The bankfull flow in most Indiana streams correlate with 1.5 to 2-year flood event flow. However, due to difficulties in determining the pre-settlement conditions, the net control of runoff resulting from a 1-year, 24 hour storm in proposed conditions (rather than the alternative method of determining increase in 2-year, 24 hour storm over pre-settlement conditions) is established as the WPWD standard for channel protection.

The WPWD has also established a minimum standard that the measurement of the effectiveness of the control of post-construction stormwater runoff quality will be based on removal of floatables in stormwater runoff and treatment, to the maximum extent practicable, of all major pollutants of concern expected for the proposed land use and/or those identified in the Storm Water Pollution Prevention Plan for the site (including, if applicable, those pollutants found to be the cause of the receiving stream to be listed in IDEM 303(d) list) for up to the first inch of rainfall at the site. The above-noted "maximum extent practicable" criterion is subject to a minimum of 80% removal of Total Suspended Solids (TSS). These requirements are adopted as the basis of the WPWD's stormwater quality management program for all areas of the jurisdiction.

For the purpose of these Standards, the control of post-construction stormwater runoff quality is assumed satisfactory when the appropriate number of pre-approved structural BMPs, tiered in accordance to the total site disturbed area as shown below, are designed, installed, and operated in accordance with fact sheets provided in Appendix 03702-1.

Disturbed Area	Post-Construction BMP Requirement*
0 to less than ½ acre	No BMP
At least ½ acre to less than 3 acres	At least 1 BMP
At least 3 acres	2 BMPs in series

* These BMPs are in addition to any pre-treatment that may be required for hot spots.

As noted above, a combination of at least two BMPs in series (each sized to handle water quality volume) is required for sites with a disturbed area of at least 3 acres, with the first BMP acting as a pretreatment measure to reduce pollutant concentrations within the downstream, or secondary, BMP. A dual BMP provision provides a failsafe benefit should

adverse conditions result in undue clogging or other potential BMP impairment. Only one of the required BMPs can be a proprietary Water Quality Device.

Requirements of the Ordinance and this Technical Standards Manual with regards to the channel protection and water quality protection can be satisfied through a variety of methods that can be broadly categorized under two general approaches:

1. Conventional Approach
2. Low Impact Development (LID) Approach

This chapter of the manual establishes minimum standards for the selection and design of post-construction water quality and channel protection BMPs. The information provided in this chapter establishes performance criteria for stormwater quality management and procedures to be followed when preparing a BMP plan for compliance. Post-construction BMPs must be sized to treat the channel protection volume (CPv), water quality volume (WQv), and for flow-through BMPs the water quality discharge rate (Qwq).

03702.02
Applicability and Exemptions

In addition to the requirements of Chapter 03600, the stormwater pollution prevention plan, which is to be submitted to the WPWD as part of the stormwater management permit application, must also include post-construction stormwater quality measures. These measures are incorporated as a permanent feature into the site plan and are left in place following completion of construction activities to continuously treat stormwater runoff from the stabilized site. Any project located within the City of Westfield jurisdictional area meeting the applicability threshold in the City of Westfield Stormwater Management Ordinance is subject to the requirements of this Chapter.

The requirements under this chapter do not apply to the following activities:

A. agricultural land disturbing activities; or
B. timber harvesting activities; or
C. construction activities associated with a single family residential dwelling disturbing less than 5 acres, when the dwelling is not part of a larger common plan of development or sale; or
D. single family residential developments consisting of four or less lots; or
E. a single-family residential strip development where the developer offers for sale or lease without land improvements and the project is not part of a larger common plan of development of sale; or
F. individual building lots within a larger permitted project.

The requirements under this chapter do not apply to the following activities, provided other applicable State permits contain provisions requiring immediate implementation of soil erosion control measures:

A. Landfills that have been issued a certification of closure under 329 IAC 10.
B. Coal mining activities permitted under IC 14-34.
C. Municipal solid waste landfills that are accepting waste pursuant to a permit issued by the Indiana Department of Environmental Management under 329 IAC 10 that contains equivalent stormwater requirements, including the expansion of landfill boundaries and construction of new cells either within or outside the original solid waste permit boundary.

It will be the responsibility of the project site owner to complete a stormwater permit application and ensure that a sufficient construction plan is completed and submitted to the WPWD in accordance with Chapter 03100. It will be the responsibility of the project site owner to ensure proper construction and installation of all stormwater BMPs (especially, the protection of the post-construction BMPs during construction phase) in compliance with all applicable ordinances and these Standards and with the approved stormwater

management permit, and to notify the WPWD with a Notice of Termination letter upon completion of the project and stabilization of the site. However, all eventual property owners of stormwater quality facilities meeting the applicability requirements must comply with the requirements of this Chapter.

03702.03
Pollutants of Concern

There are three major sources of pollutants for a stabilized construction site:

- Deposition of atmospheric material (including wind-eroded material and dust)
- General urban pollution (thermal pollution, litter)
- Pollutants associated with specific land uses

It should be noted that some pollutants accumulate on impervious surfaces. This accumulated material is then subject to being washed into watercourses during storm events. It is for this reason that fish kills often occur during a rain event with a substantial prior rainless period. This is also the reason that the most hazardous driving conditions are realized after the initial onset of a storm event, when deposited oil has not yet washed into adjacent conveyance systems.

Post-construction pollutants of concern include:

- **Sediment** is the major pollutant of concern during active construction. Natural erosion processes are accelerated at a project site by the construction process for a number of reasons, including the loss of surface vegetation and compaction damage to the soil structure itself, resulting in reduced infiltration and increased surface runoff. After the construction is completed, other chemicals that are released to surface waters from industrial and municipal discharges and polluted runoff from urban and agricultural areas continue to accumulate to harmful levels in sediments.

- **Toxic chemicals** from illegal dumping and poor storage and handling of materials. Industrial sites pose the most highly variable source of this pollution due to the dependency of the specific process to the resulting pollution amounts and constituents. As during construction, these chemicals can pose acute (short-term) and/or chronic (long-term) risk to aquatic life, wildlife and the general public.

- **Bacteria** from illicit sanitary connections to storm sewer systems, combined sewers, leaking septic systems, wildlife and domestic animal waste. Bacteria pathogens pose a direct health risk to humans and aquatic life.

- **Nutrients** can be released from leaking septic systems or applied in the form of fertilizers. Golf courses, manicured landscapes and agricultural sources are the primary land uses associated with excess fertilization. Excessive nutrients in the local ecosystem are the source of algal blooms in ponds and lakes. These excessive nutrients also lead to acceleration of the eutrophication process, reducing the usable lifespan of these water bodies. Nitrogen and phosphorous are the primary nutrients of concern.

- **Oxygen demand** can be impacted by chemicals transported on sediment, by nutrients, and other pollutants (such as toxic chemicals). Reduced levels of oxygen impair or destroy aquatic life.

- **Oils and hydrocarbons** accumulate in streets from vehicles. They can also be associated with fueling stations and illicit dumping activities. Oils and hydrocarbons pose health risk to both humans and aquatic life.

- **Litter, including floatables,** can result in a threat to aquatic life. The aesthetic impact can also reduce the quality of recreational use.

- **Metals** can be associated with vehicular activity (including certain brake dusts), buildings, construction material storage, and industrial activities. Metals are often toxic to aquatic life and threaten human health.

- **Chlorides** (salts) are historically associated with deicing activities. Chlorides are toxic to native aquatic life (verses saltwater aquatic life). Communities should consider a combination or cinders or sand to replace or supplement their deicing activities with chlorides. In addition, chloride stockpiles should remain covered.

- **Thermal effects** can be introduced by the removal of shade provided by riparian trees, as well as impervious channel linings, such as concrete, which release stored heat to water passing over them. Other sources of elevated temperature include effluent from power plant and industrial activities. Thermal pollution can threaten aquatic habitat, including fish species and beneficial water insects. Of particular concern are salmonoid streams, due to the effect of thermal pollution on spawning for this particular species.

Direct water quality sampling is not generally required at this time under the Phase II provisions. However, water quality characteristics are strongly tied to land use. For the purpose of these standards, all proposed developments and re-developments shall be assumed to involve increased levels of floatables, TSS, TP, TN, and metals. Additional pollutants may also be expected at certain types of developments and specific sites, as identified in the Storm Water Pollution Prevention Plan for the site (including, if applicable, those pollutants found to be the cause of the receiving stream to be listed in IDEM 303(d) list).

03702.04
Conventional
Approach Procedures

The following procedures shall be followed according to the Conventional approach:

Step 1: <u>Provide BMPs to address Channel Protection Volume</u>

In a conventional approach, the receiving channel is protected through extended detention of the 1-year, 24 hour storm event on the entire site (disturbed and undisturbed) tributary to each outlet. Both wet and dry extended detention may be used so long as only 10% of the maximum stored volume is left in the basin after 36 hours from maximum storage time and no more than 40% of the maximum stored volume is released within the first 12 hours. To ensure that adequate detention volume is available within the facility over the years, the facility should be designed for long-term (a minimum of 50 years) sediment accumulation. If long-term sediment accumulation cannot be adequately provided for in the pond, or if the pond is intended to provide sediment control during the construction phase of the project, forebays near inlets can be included to help manage sediment accumulation.

Since, by design, 90% of the original volume will be available within 48 hours of the start of each storm event (assumed to be about 36 hours from when the Channel Protection pool is full), the volume in the pond associated with the channel protection (CPv) may be assumed empty for the purpose of peak flow detention analysis discussed in Chapter 03300. In addition, the volume provided for channel protection would also satisfy the water quality volume (WQv) requirement provided that the facility meets the design criteria in the fact sheet and additional pre-treatment and/or wetland fringe can be provided to assure the treatment benchmarks noted in Section 03702.01 of these Standards are met.

The methodology for calculating the Channel Protection Volume (CPv) for each of site's final outlets using computer models or manual calculation is as follows:

- Computer Model: Use acceptable computer models (listed in Chapter 03200) to determine the total runoff volume for the site contributing to each site's outlet, utilizing 1-year, 24 hour rainfall depth with Soil Conservation Service (SCS) type 2 storm distribution, drainage area, and the composite CN calculated for the site, according to the Soil Conservation Service (SCS) CN loss method along with SCS unitless hydrograph methodology.
- Manual Calculation: If calculating manually, use the following formula:

Runoff Volume (ft3) = Qv x 1/12 x A

where:
A = total post-construction site area contributory to each outlet (ft^2)
Qv = Runoff Depth (in) = $(P - 0.2S)^2/(P + 0.8S)$
P = 1-Year, 24-hr Rainfall (in)
S = 1000/CN – 10

Step 2: <u>Provide BMPs to address Water Quality Management</u>

When the channel protection volume is controlled with BMPs that also meet the stormwater quality performance criteria noted in Section 03702.01, often no additional calculation or BMP implementation is necessary. If the channel protection volume is not controlled through practices that meet the stormwater quality performance criteria in Section 03702.01, additional BMPs will be required.

The WPWD has designated a number of pre-approved structural BMP methods (listed in Table 03702-1 for Conventional Approach and Tables 03702-4 through 03702-6 for LID Approach) to be used alone or in combination to achieve the stormwater quality performance criteria noted in Section 03702.01 of these Standards for runoff generated from up to first inch of rainfall on the entire site (disturbed and undisturbed) tributary to each outlet. Details regarding the applicability and design of these pre-approved BMPs, including the effectiveness of these BMPs in treating pollutants of concern (including, if applicable, those pollutants found to be the cause of the receiving stream to be listed in IDEM 303(d) list), are contained within fact sheets presented in Appendix 03702-1. Additional information on recommended plant lists and recommended materials used for construction of stormwater BMPs are provided in Appendix 03702-2 and Appendix 03702-3, respectively.

Innovative BMPs, including but not limited to, BMPs not previously accepted by the WPWD must be certified by a Professional Engineer licensed in State of Indiana and approved through the WPWD. ASTM standard methods must be followed when verifying performance of new measures. New BMPs, individually or in combination, must meet the performance criteria noted in Section 03702.01 of these Standards, including the capture and removal of floatables. All innovative BMPs must have a low to medium maintenance requirement to be considered by the WPWD. Testing to establish the pollutant removal rate must be conducted by an independent testing facility, not the BMP manufacturer. The accepted design flow rate for a Water Quality Device shall be the flow value at which the claimed removal rate for TSS is equaled or exceeded based on the unit's efficiency curve (flow rate versus removal rate graph). In rare cases where structural BMPs may not be appropriate or practical, public education may be substituted in lieu of a structural BMP. This option will be at the discretion of the WPWD.

Structural Water Quality treatment is achieved by treating the first inch of rainfall, either through detention/retention BMPs or by Flow-through BMPs. Detention/Retention BMPs impound (pond) the runoff to be treated (Water Quality Volume: WQv), while flow-through BMPs treat the runoff through some form of filtration process (Water Quality Treatment Rate: Qwq). The following methods are used as part of Conventional Approach to calculate WQv and Qwq:

<u>Water Quality Volume (WQv)</u>

Water Quality Detention BMPs must be designed to store the water quality volume for treatment. The water quality volume, WQv, is the storage needed to capture and treat the runoff from the first one inch of rainfall. The water quality volume is equivalent to one inch of rainfall multiplied by the volumetric runoff coefficient (Rv) multiplied by the site area.

A calculation methodology similar to that described for the channel protection volume may be utilized, except that the rainfall depth (P) will be equal to 1, instead of the 1-year, 24 hour depth.

Alternatively, a simpler methodology may be used for calculation of WQv as follows:

$$WQv = (P)\ (Rv)\ (A)/12$$

where:
WQv = water quality volume for each site's outlet (acre-feet)
P = 1 (inches)
Rv = volumetric runoff coefficient
A = total contributing area to each site's outlet in acres

The volumetric runoff coefficient is a measure of imperviousness for the contributing area, and is calculated as:

$$Rv = 0.05 + 0.009(I)$$

where:
I is the percent impervious cover

For example, a proposed commercial site will be designed to drain to three different outlets, with the following drainage areas and impervious percentages:

Subarea ID	On-site Contributing Area (acres)	Impervious Area %	Off-Site Contributing Area (acres)
A	7.5	80	0.0
B	4.3	75	0.0
C	6.0	77	0.0

Calculating the volumetric runoff coefficient for subareas A, B and C yields:

Rv (subarea A) = 0.05+0.009(80) = 0.77
Rv (subarea B) = 0.05+0.009(75) = 0.73
Rv (subarea C) = 0.05+0.009(77) = 0.74

The water quality volumes for these three areas are then calculated as:

WQv (subarea A) = (1")(Rv)(A)/12=0.77(7.5)/12=0.48 acre-feet
WQv (subarea B) = 0.73(4.3)/12=0.26 acre-feet
WQv (subarea C) = 0.74(6.0)/12=0.37 acre-feet

Note that this example assumed no offsite sources of discharge through the channel protection detention/retention BMPs. If there are significant sources of off-site runoff, the designer has the option of diverting off-site runoff around the on-site systems, or the detention BMP should be sized to treat the water quality volume for the entire contributing area, including off-site sources.

Water Quality Treatment Rate (Qwq)

Flow-through BMPs are designed to treat runoff at a peak design flow rate through the system. Examples of flow through BMPs include catch basin inserts, sand filters, and grassed channels. Another flow through BMP which is gaining popularity is a hydrodynamic separator or other similar type of device discussed in the Water Quality Devices Fact Sheet (Appendix 03702-1). Hydrodynamic separators are proprietary, and usually include an oil-water separation component. Hydrodynamic separators (i.e. Gravity or Manufactured Stormwater Quality Units) located on the City of Indianapolis Stormwater Quality Unit Selection Guide will be accepted when installed off-line. New units not on this list will be accepted on a case by case basis with 3rd party testing data and specifications required as well as a written narrative explaining the water quality benefits of the BMP. Runoff rate calculations for each site should be completed according to the instructions in these Standards for the one inch rainfall event. Once a runoff rate has been determined, a unit with a corresponding acceptable treatment rate can be selected from the Indianapolis selection guide. For treatment device Operation and Maintenance manuals, applicants shall at a minimum follow the standard treatment unit checklists and notes as provided in the selection guide unless these conflict with other City of Westfield Public Works Department Standards and Specifications. In the event that the Indianapolis selection guide no longer exists, applicants shall provide independent, third party documentation to prove that a treatment unit meets TSS removal to the highest extent practicable for a particle size of 50-125 microns and/or the OK-110 particle size distribution. If the City of Indianapolis selection guide is not used and for innovative BMPs, the accepted design flow rate for a Water Quality Device shall be the flow value at which the claimed removal rate for TSS is equaled or exceeded based on the unit's efficiency curve (flow rate versus removal rate graph).

The following procedure should be used to estimate peak discharges for flow through BMPs (adopted from Maryland, 2000). It relies on the volume of runoff computed using the Small Storm Hydrology Method (Pitt, 1994) and utilizes the NRCS, TR-55 Method.

Using the WQv methodology, a corresponding Curve Number (CNwq) is computed utilizing the following equation:

$$CNwq = \frac{1000}{\left[10 + 5P + 10Qa - 10\sqrt{Qa^2 + 1.25QaP}\right]}$$

where:
CNwq = curve number for water quality storm event
P = 1" (rainfall for water quality storm event)
Qa = runoff volume, in inches = 1"×Rv = Rv (inches)
Rv=volumetric runoff coefficient (see previous section)

Due to the complexity of the above equation, the water quality curve number is represented as a function of percent imperviousness in Exhibit 03701-1.

The water quality curve number, CNwq, is then used in conjunction with the standard calculated time-of-concentration, tc, and drainage area as the basis input for TR-55 calculations. Using the SCS Type II distribution for 1 inch of rainfall in 24 hours, the water quality treatment rate, Qwq, can then be calculated.

Note that a single BMP measure may not be adequate to achieve the water quality requirements (as noted above) for a project. It is for this reason that a "treatment train", a number of BMPs in series, is often required for a project. The pollutant removal efficiency of a number of BMPs in series may be determined from the following formula:

$$E_{series} = 1 - (1-E_1)(1-E_2)(1-E_3)\ldots$$

where:
E_{series} = Removal Efficiency of the BMP series combined (in decimal form)
$E_1, E_2, E_3, \ldots$ = Removal Efficiency of Units 1, 2, 3, …, respectively (in decimal form)

03702.05 LID Stormwater Management Approach

Low impact development (LID) stormwater management design approaches are fundamentally different from conventional design approaches and challenge traditional thinking regarding development standards, watershed protection, and public participation. LID combines fundamental hydrologic concepts with many of today's common stormwater strategies, practices and techniques to reshape development patterns in a way that maintains natural watershed hydrologic functions. When a county or community has a stormwater user fee system based on imperviousness, the utilization of LID concepts also often results in a smaller stormwater user fee for non-residential lots. The five principles of LID are:

a) Conservation of existing natural and topographic features;
b) Minimization of land clearing and impervious surfaces;
c) Maintain or lengthen the pre-developed time of concentration;
d) Installation of integrated structural best management practices; and
e) Use of pollution prevention measures and practices.

Several methods for achieving the above requirements and principals are outlined below. In addition to methods described in this Standards Manual, several readily available references provide details on incorporating LID practices into site development. One of the most recent, comprehensive resources for incorporating LID practices into site development design is "Low Impact Development Manual for Michigan: A Design Guide for Implementers and Reviewers" available online at www.semcog.org/LowImpactDevelopment.aspx. The noted resource was used extensively for the development of LID section in this Standards Manual.

The following steps shall be followed for the LID approach:

Step 1: <u>Minimize Disturbed Areas and Protect Sensitive Areas</u>

- Map sensitive areas such as waterbodies, floodplains, and natural flow paths. Identify hydrologic soil types on the maps. Show elevations and identify critical slopes of 15 percent to 25 percent and above 25 percent. Show areas of known contamination. Also show existing structures and infrastructure.
- Determine the total area of impervious surface existing prior to development.
- Note the seasonal high groundwater level.
- Designate sensitive areas that are proposed to be protected as part of the proposed layout.
- Lay out the proposed development, minimizing disturbance and avoiding the sensitive areas.
- Utilize the non-structural BMPs listed in Table 03702-2 to properly protect sensitive areas so they maintain their pre-development state and runoff characteristics. Fact sheets for non-structural BMPs are provided in Appendix 03702-1.
- As shown in Table 03702-2, when using the LID Approach, any area that is set aside and protected as described in those BMPs may be subtracted from site development area for purposes of determining Channel Protection Volume calculations and water quality volume/rate calculations.
- In addition, for determining the 10-year and 100-year runoff and peak discharges, the CN associated with the original, pre-development soil groups

(instead of the normal requirement of assigning the post-development CN according to the next lower infiltration soil group) may be used for these areas (see Table 03702-8).

- The runoff reduction recognition only works with designs based on the Curve Number or CN method of analysis utilizing non-composite CN determination methods.

Step 2: <u>Restore Disturbed Areas</u>

- For the LID Approach, runoff reduction recognitions are used in the design process to emphasize the use of BMPs that, when applied, restore/alter the disturbed area in a way that reduces the volume of runoff from that area.
- Runoff reduction recognition is provided for the five BMPs listed in Table 03702-3 because they enhance the response of a piece of land to a storm event rather than treat the runoff that is generated. These BMPs are encouraged because they are relatively easy to implement over structural controls, require little if any maintenance, and the land they are applied to remains open to other uses.
- Runoff reduction recognition is applied by reducing the default CN value so that the amount of runoff generated from an event is reduced.
- The runoff reduction recognition only works with designs based on the Curve Number or CN method of analysis utilizing non-composite CN determination methods.
- Fact sheets for these BMPs are provided in Appendix 03702-1.

Step 3: <u>Minimize Imperviousness</u>

- The BMPs listed in Table 03702-4 are designed to reduce the volume of runoff from hard surfaces such as roads, sidewalks, parking areas, roofs, etc. For the LID Approach, runoff reduction recognition is used to encourage these practices and recognize their runoff reduction impacts. Fact Sheets for these BMPs are provided in Appendix 03702-1.
- Although imperviousness reduction BMPs are encouraged throughout any new development or re-development, the runoff reduction recognitions may only be considered where the following conditions are met:
    - The BMP must be in the common areas and covered by an easement or other agreement that assigns responsibility for its maintenance.
    - The BMP must be covered by a maintenance plan and agreement with assurances for the long-term availability of maintenance funds (such as funds held in a permanent escrow account) provided to the WPWD in a form acceptable to the WPWD.

Step 4: <u>Calculate the amount of volume control needed for channel protection</u>

- Determine the 1-year, 24 hour rainfall from Table 03201-3 in Chapter 03200.
- Delineate subbasins in a manner that, at a minimum and to the extent possible, the pervious and impervious surfaces are in different subbasins.
- Determine the disturbed drainage area for each subbasin by subtracting the protected area determined in Step 1 from total contributing drainage area.
- Assign CN to each cover type and land use, assigning "credited CN" for areas treated in Steps 2 and 3 instead of normal post-development CN that is determined based on the proposed land use and the next less infiltrating underlying soil group, when applicable. Published pre-determined weighted CN values shall <u>not</u> be utilized for LID Approach. This applies regardless of whether manual methods or computer modeling techniques are used.
- Determine the total post-development 1-year, 24 hour runoff volume for the entire site's disturbed areas through the use of acceptable computer models

or manually as specified below. This is the net Channel Protection volume needing to be permanently removed by appropriate structural BMPs.

- Computer Model: Use acceptable computer models (listed in Chapter 03200) to determine the total runoff volume for the site contributing to each site's final outlet, utilizing 1-year, 24 hour rainfall depth with Soil Conservation Service (SCS) type 2 storm distribution, drainage area, and CN determined above, according to the Soil Conservation Service (SCS) CN loss method along with SCS unitless hydrograph methodology.
- Manual Calculation: If calculating manually, use the following formula:

  Runoff Volume (ft^3) for each post-construction cover type contributing to each outlet = Qv x 1/12 x A

  where:
  A = disturbed area of the particular cover type (ft^2)
  Qv = Runoff Depth (in) = $(P - 0.2S)^2/(P + 0.8S)$
  P = 1-Year, 24-hr Rainfall (in)
  S = 1000/CN – 10

  - Sum the individual volumes to obtain the total post-development runoff volume for area to be managed.

Step 5: Provide Distributed Volume Reduction/Infiltration Practices

- Table 03702-5 includes a list of the structural BMPs from potential BMPs that provide volume removal. Select and design structural BMPs that provide volume control to meet, when combined, the total net channel protection volume determined in Step 4. Fact sheets for these and other relevant post-construction structural BMPs are provided in Appendix 03702-1.
- The volume reduction BMPs may not be successfully implemented in every situation. See "Applicability and Limitation" discussions in each fact sheet. In order to qualify for volume reduction recognition, the BMPs must meet all the following:
  - Be in the common areas and covered by an easement or other agreement that assigns responsibility for its maintenance.
  - Be covered by a maintenance plan and agreement with assurances for the long-term availability of maintenance funds (such as funds held in a permanent escrow account) provided to the WPWD in a form acceptable to the WPWD.
  - Be constructed on undisturbed A or well-drained B soils (B/D soils do not qualify) or amended soil with underdrains, as needed. If underdrains are used, the bottom elevations of the underdrains should be above the seasonal high water table. Soil infiltration testing protocol, provided in Appendix 03702-4, must be followed to determine if infiltration BMPs are suitable at a site and to obtain the required data (such as soil conditions and depth of seasonal high water table) for infiltration design.
  - Be constructed in an area where the depth of seasonal high water table and any bedrock is more than a minimum of 2 feet (4 is desirable) from ground elevation.
  - Be constructed in a manner that any infiltration practices are adequately separated from basement foundations (50 feet up gradient, 10 feet down gradient), on-site septic systems/drainfields (100 feet), wells (50 feet), and other building elements that could be affected by infiltration systems.
  - Be constructed outside of any 1-year (Zone 1) or 5-year (Zone 2) time of travel areas to public water supply wells, as defined by a modeled wellfield delineation performed in compliance with 327

IAC 8-4.1. When such delineation is not available, said practice must be at least 3,000 feet from the nearest public water supply well (unless applicant can demonstrate that the proposed practice will have no impacts on the water quality of the water supply well).

- Final construction should be completed after the contributing drainage area has been stabilized.
- Must contain erosion-protection features at the inflow to prevent scouring
- Must contain a maintenance area near the inlet to collect large debris. Examples include small concrete aprons, catch basin inserts, or similar durable maintenance point.

- When the LID Approach is being pursued in all other aspects of the design but site limitations would not allow permanent volume reduction practices, channel protection volume should, at a minimum and as site limitations would allow, be accommodated through distributed storage solutions noted in Table 03702-5 that also include underdrains as described in the appropriate Fact Sheets so that at a minimum they can act as both extended detention and filtration practices.
- **Calculation Methods for Recognizing Impacts of Distributed Storage on Overall Site's Peak Flow Detention Requirements:** When all the stated conditions above are met for volume-reduction distributed storage practices noted in Table 03702-5, total volume provided for channel protection within distributed storage units (not to exceed the required channel protection volume calculated in Step 4) may be credited towards the site's detention requirements for peak (100-year) flow control (see Table 03702-8). Several methods are available to account for the noted runoff reduction recognition. A few common methods are listed below (other methods not noted below may also be used as appropriate):
  - Method 1: Assume that the provided Channel Protection Volume in the distributed storage units (not to exceed the required channel protection volume calculated in Step 4) will be stored below the detention pond's normal pool (below the lowest outlet). To simulate this condition, all the volumes in the elevation-storage table are increased by the provided Channel Protection Volume, an additional table entry is made as the first row with an artificial lower elevation and with zero for storage, and the reservoir's starting elevation is set at the noted artificial elevation.
  - Method 2: Utilize the "Divert" option of the hydrologic model used to compute the inflow to the pond to simulate the diversion (abstraction) of the provided Channel Protection Volume (not to exceed the required channel protection volume calculated in Step 5) from the detention pond inflow before the remaining flood hydrograph is routed through the detention system. To accomplish this, the model should have capability to simulate diversion with a volume cap option.
  - Method 3: Explicitly model the distributed storage features as a network of storage and conveyance units through the use of computer programs that can correctly model interconnected storage.

Step 6: <u>Provide Additional (as-needed) Extended Detention Practices</u>

- When the LID Approach is being pursued in all other aspects of the design but site limitations would not allow adequate distributed volume reduction practices noted in Step 5 (with or without underdrain), then a constructed wetland or a wet-bottom extended detention facility along with incorporation of an appropriate wetland fringe should be utilized as listed in Table 03702-6. If designed properly, such a facility can be incorporated into a multi-purpose facility to control channel protection volume, water quality volume,

and 100-year peak flow rate. Note that since by design conditions of a wet-bottom extended detention facility, 90% of the original volume will be available within 48 hours of each storm event (i.e., a maximum of 36 hours from when the channel protection pool is full), the volume in the pond associated with the channel protection may be assumed empty for the purpose of peak flow detention analysis discussed in Chapter 03300 of these Standards (see Table 03702-8).

Step 7: <u>Determine Water Quality Volume and Provide, As-needed, Additional Water Quality BMPs</u>

- The expected treatment of many BMPs applied to LID designs is based on removing solids. Many pollutants are attached to solids or are removed by similar treatment mechanisms. Therefore, removing solids can act as a surrogate for the expected removal of other particulate pollutants. Often multiple BMPs will be necessary to remove successively smaller particle sizes to achieve the highest level of treatment.
- When the channel protection volume is controlled with BMPs that also meet the stormwater quality performance criteria in Section 03702.01, often no additional calculation or BMP implementation is necessary. If the channel protection volume is not controlled through practices that also meet the stormwater quality performance criteria in Section 03702.01, calculate the water quality volume that provides for the treatment of the first inch of rainfall on the site's disturbed areas as discussed below.
- The methodology to determine the design water quality volume or rate for the LID approach is the same as that described for the Channel Protection Volume calculation described in Step 4, except that the rainfall depth for the Water Quality will be 1 inch instead of the 1-year, 24 hour rainfall depth used for calculating the Channel Protection Volume. A few considerations specific to Water Quality Volume/Rate calculations are as follows:
    - Time of Concentration in the case of LID design is the time it takes a drop of water to move from the furthest point in the disturbed area to its discharge from the disturbed area.
    - Computer Model: If using acceptable computer models, perform the same procedure as that performed for calculating CPv in Step 4, but for 1 inch of rainfall depth.
    - Manual Calculation: If calculating manually, use the following formula:

      Runoff Volume (ft^3) for each cover type = Qv x 1/12 x A

      where:
      A = disturbed area of the particular cover type (ft^2)
      Qv = Runoff Depth (in) = $(P - 0.2S)^2/(P + 0.8S)$
      P = 1 inch
      S = 1000/CN – 10

      Peak Runoff Rate (ft^3/sec) = qu x A x Qv x1/43,560

      where:
      A = disturbed area of the particular cover type (ft^2)
      Qv = Runoff Depth (in) calculated in previous step
      q_u = Unit Peak Discharge (cfs/mi^2/in), determined from TR-55 Exhibit 4-II

- Sum the individual volumes and peak runoff rates to obtain the total design post-development water quality runoff volume and rate.

- Determine the total post-development water quality runoff volume and rate for the entire site's disturbed areas. These are the design post-development water quality runoff volume and rate needing to be treated.

- Select BMPs from the list provided in Table 03702-1 that will meet the performance criteria noted in Section 03702.01 of this Chapter. Often, multiple types of BMPs used in series will be required to provide adequate treatment. Design the BMPs in conjunction with any detention control that is needed for peak rate control of larger floods (100-year), if possible.

Step 8: <u>Complete the LID Approach Utilization Summary Form</u>

- As the final step of the LID Approach, a summary of non-structural and structural BMPs utilized, as part of the LID Approach, in the site design of a particular development site is provided in Table 03702-7 and submitted as part of the permit request package.
- The presence of Table 03702-7 in the submittal package and the information contained in the form would alert the plan reviewer that the LID Approach is being used to meet the post-construction stormwater quality requirements of the site and that the overall site design as well as peak discharge and detention calculations should be reviewed with the impacts of LID Approach in mind.

<u>Summary of Runoff Reduction Recognitions for Water Quality Volume, Channel Protection, and Peak Flow Control Detention Volume for LID approach</u>

As discussed throughout this Section, to encourage LID approach for stormwater management, runoff reduction recognitions towards all three major stormwater management requirements, i.e., Water Quality, Channel Protection, and Peak Runoff Detention, are associated with various BMPs as noted through the above 8-step process. These runoff reduction recognitions are summarized in Table 03702-8.

03702.06
Special Provisions for "Hot Spot" Land Uses

For all those projects involving land uses considered to be high pollutant producers or "hot spots" (see Table 03702-9 e.g., vehicle service and maintenance facilities, vehicle salvage yards and recycling facilities, vehicle and equipment cleaning facilities, fleet storage areas for buses, trucks, etc., industrial/commercial or any hazardous waste storage areas or areas that generate such wastes, industrial sites, restaurants and convenience stores, any activity involving chemical mixing or loading/unloading, outdoor liquid container storage, public works storage areas, commercial container nurseries, and some high traffic retail uses characterized by frequent vehicle turnover), additional water quality requirements may be imposed by the WPWD in addition to those included in water quality criteria in order to remove potential pollutant loadings from entering either groundwater or surface water systems. These pre-treatment requirements are included in Table 03702-9 and Table 03702-10.

03702.07
Construction Sequencing Considerations

BMPs noted in this chapter refer to post-construction BMPs, which continue to treat stormwater after construction has been completed and the site has been stabilized. Installing certain BMPs, such as bioretention areas and sand filters, prior to stabilization can cause failure of the measure due to clogging from sediment. If such BMPs are installed prior to site stabilization, they should be protected by traditional erosion control measures.

In those instances, the construction sequence must require that the pond is cleaned out with pertinent elevations and storage and treatment capacities reestablished as noted in the accepted stormwater management plan.

03702.08
Easement Requirements

All stormwater quality management systems, including detention or retention basins, filter strips, pocket wetlands, in-line filters, infiltration systems, conveyance systems, structures and appurtenances located outside of the right-of-way shall be designated as common areas and incorporated into permanent, exclusive easements. For developments which fall under the jurisdictional authority of Hamilton County Drainage Board, the developer shall petition to establish the noted system as a portion of regulated drainage system pursuant to the provisions of I.C.-36-9-27, and the drainage plan shall not be accepted until such petition is submitted in a form accepted by Hamilton County Drainage Board. For the purposes of access, monitoring, inspection, and general maintenance activities, adequate easement width, as detailed in Table 03701-1, beyond the actual footprint of the stormwater quality management facility as well as a 20-foot wide access easement from a public right-of-way to each BMP shall be provided. The easement requirements noted in Table 03701-1 and this section may be changed by WPWD as deemed necessary for specific cases. In addition, protected/restored areas for which recognition is sought (Steps 1 and 2 of LID Approach) must be left undisturbed in perpetuity and covered by a conservation easement or a similar instrument to ensure non-disturbance in perpetuity.

03702.09 Inspection, Maintenance, Record Keeping, and Reporting

After the approval of the stormwater management permit by WPWD and the commencement of construction activities, the WPWD has the authority to conduct inspections of the work being done to ensure full compliance with the provisions of this chapter, this document, and the terms and conditions of the approved permit.

Stormwater quality facilities shall be maintained in good condition, in accordance with the Operation and Maintenance procedures and schedules listed in this document, and/or the terms and conditions of the approved stormwater permit, and shall not be subsequently altered, revised, or replaced except in accordance with the approved stormwater permit, or in accordance with approved amendments or revisions in the permit. Checklists provided in Appendix 03702-5 or equivalent forms must be completed and maintained by the owner. In addition, a maintenance agreement in the format provided in Appendix 03702-6 shall be executed for all proposed stormwater management BMPs and submitted as part of the project permit package.

The WPWD also has the authority to perform long-term, post-construction inspection of all public or privately owned stormwater quality facilities. The inspections will follow the Operation and Maintenance procedures included in this document and/or permit application for each specific BMP. The inspection will cover physical conditions, available water quality storage capacity and the operational condition of key facility elements. Noted deficiencies and recommended corrective action will be included in an inspection report.

BMP[A]	Typical % Removal Efficiency[B]	Maintenance Easement Requirements
	TSS	
Bioretention	90[C]	25 feet wide along the perimeter
Constructed Wetland	67[C]	25 feet wide along the outer perimeter of forebay & 30 feet wide along centerline of outlet
Underground Detention	70	20 feet wide strip from access easement to tank's access shaft & 30 feet wide along centerline of inlet and outlet
Extended Detention/Dry Pond	72	25 feet wide along the outer perimeter of forebay & 30 feet wide along centerline of outlet
Infiltration Basin	87	25 feet wide along the perimeter
Infiltration Trench	90[C]	25 feet wide along the perimeter
Constructed (Sand) Filter	70[C]	25 feet wide along the perimeter
Water Quality Device	NA[D]	20 feet wide strip from access easement to chamber's access shaft
Vegetated Filter Strip	78[C]	25 feet wide along the length on the pavement side
Vegetated Swale	81[C]	25 feet wide along the top of bank on one side
Wet Ponds/Retention Basin	80	25 feet wide along the outer perimeter of forebay & 30 feet wide along centerline of outlet

Notes:

A. Detailed specifications for these BMPs are provided in the fact sheets contained in Appendix 03702-1.
B. Removal rates shown are based on typical results. Unless otherwise shown, data extracted by CBBEL from various data sources. These rates are also dependent on proper installation and maintenance. The ultimate responsibility for determining whether additional measures must be taken to meet the Ordinance requirements for site-specific conditions rests with the applicant.
C. IDEM Stormwater Quality Manual, 2007.
D. The removal rate for this category varies widely between various models and manufacturers. Independent testing must be provided, rather than the manufacturer's testing data. In lieu of Independent testing data, the latest pre-approved proprietary BMPs list from the City of Indianapolis. These BMPs must be configured as offline units. The accepted design flow rate for a Water Quality Device shall be the flow value at which 80% TSS removal rate is equaled or exceeded based on the unit's efficiency curve (flow rate versus removal rate graph).

TABLE 03702-1: Pre-approved Post-Construction BMPs for Conventional Approach

BMP[A]	Runoff Reduction Recognition[B]
Protect Sensitive Areas	Area (acres complying with the requirements of this BMP) can be subtracted from site development area for Channel Protection Volume and Water Quality Volume/Rate calculations.
Protect Riparian Buffers	Area (acres complying with the requirements of this BMP) can be subtracted from site development area for Channel Protection Volume and Water Quality Volume/Rate calculations.
Minimize Total Disturbed Area	Area (acres complying with the requirements of this BMP) can be subtracted from site development area for Channel Protection Volume and Water Quality Volume/Rate calculations.
Reduce Impervious Surfaces	Area (acres complying with the requirements of this BMP) can be subtracted from site development area for Channel Protection Volume and Water Quality Volume/Rate calculations.
Protect Natural Flow Pathways	Area (acres complying with the requirements of this BMP) can be subtracted from site development area for Channel Protection Volume and Water Quality Volume/Rate calculations.
Cluster-Type Development	Area (undisturbed acres complying with the requirements of this BMP) can be subtracted from site development area for Channel Protection Volume and Water Quality Volume/Rate calculations.

Notes:

A. In using and crediting these BMPs, applicants must meet the review criteria located within the discussion of each BMP provided in Appendix 03702-1.

B. If the LID track is pursued, reduced CNs (associated with pre-developed underlying soil types instead of the normal requirement of assigning the post-development CN according to the next lower infiltration soil group) for areas protected by these BMPs may be used for determining the post-developed runoff rates and volumes for larger events (up to and including the 100-year event). See **Table 03702-8**.

TABLE 03702-2:Pre-approved BMPs with Treatment Area Reduction Recognition for LID Approach

BMP[A]	Runoff Reduction Recognition[B]
Minimize Soil Compaction	Area (acres complying with the requirements of this BMP) can be assigned a CN based on the Pre-developed soil group conditions instead of the normal requirement of assigning the post-development CN according to the next lower infiltration soil group.
Protection of Existing Trees within disturbed areas (part of Protect Sensitive Areas)	Trees protected under the requirements of this BMP can be assigned a CN based on the Pre-developed soil group conditions at a rate of 800 square feet per tree instead of the normal requirement of assigning Post-developed CN according to the next lower infiltration soil group for the acres covered by the tree area.
Soil Amendment and Restoration	Area (acres complying with the requirements of this BMP) can be assigned a CN based on the Pre-developed soil group conditions instead of the normal requirement of assigning the post-development CN according to the next lower infiltration soil group.
Native Revegetation	Proposed trees and shrubs to be planted under the requirements of this BMP can be assigned a CN based on the Pre-developed soil group conditions at a rate of 200 square feet per tree and 25 square feet per shrub instead of the normal requirement of assigning Post-developed CN according to the next lower infiltration soil group for the acres covered by the existing land use area.
Riparian Buffer Restoration	Proposed trees and shrubs to be planted under the requirements of this BMP can be assigned a CN based on the Pre-developed soil group conditions at a rate of 200 square feet per tree and 25 square feet per shrub instead of the normal requirement of assigning Post-developed CN according to the next lower infiltration soil group for the acres covered by the existing land use area.

Notes:

A. In using and crediting these BMPs, applicants must meet the review criteria located within the discussion of each BMP provided in Appendix 03702-1.

B. If the LID track is pursued, reduced CNs (associated with pre-developed underlying soil types instead of the normal requirement of assigning the post-development CN according to the next lower infiltration soil group) for areas covered by these BMPs may be used for determining the post-developed runoff rates and volumes for larger events (up to and including the 100-year event). See **Table 03702-8**.

Table 03702-3: Pre-approved BMPs with CN Reduction Recognition for Restoring Disturbed Areas as Part of LID Approach

BMP[A]	Runoff Reduction Recognition[B]
Porous Pavement	Area covered by Porous Pavement with a minimum of 8 inch washed aggregate base may be assigned a weighted CN value of 87 (instead of CN of 98 normally used for impervious surfaces) for the purpose of Channel Protection Volume calculations. Use a weighted CN of 74 for the purpose of Water Quality Volume calculations, if needed. Note: If this BMP is specifically designed to provide permanent volume reduction through infiltration or through providing detention storage within the aggregate void, the volume reduction recognition discussed in Step 5 should be pursued instead of the CN reduction credit, assuming CN of 98.
Vegetated Roof	Vegetated roofs are designed to reduce runoff volumes. However, the volume reduction is highly dependent on the media and planting used, with the calculation methods very complex at times. In lieu of calculating the volume reduction benefits, the roof area with vegetated roof with a minimum media depth of 4 inches and a void ratio of 0.3 (as described in the fact sheet) may be assigned a weighted CN of 87 (instead of CN of 98 normally used for impervious surfaces) for the purpose of Channel Protection Volume calculations. Use a weighted CN of 74 for the purpose of Water Quality Volume calculations, if needed.

Notes:

A. In using and crediting these BMPs, applicants must meet the review criteria located within the discussion of each BMP provided in Appendix 03702-1.

B. If the LID track is pursued, reduced CNs for areas covered by these BMPs may be used for determining the post-developed runoff rates and volumes for larger events (up to and including the 100-year event). See **Table 03702-8** for weighted CN values used for such larger events.

Table 03702-4: Pre-approved BMPs with CN Reduction Recognition for Reducing Imperviousness as Part of LID Approach

BMP[A]	Channel Protection Volume Reduction Recognition[B]
Infiltration Practices (Infiltration Basin, Subsurface Infiltration Bed, Infiltration Trench, and Dry Well)	Volume reduction is achieved by surface storage volume (if included in the design), subsurface volume (if included in the design), and infiltration volume as described in the fact sheet. If an underdrain has to be used due to soil conditions, no credit is granted for the "infiltration volume" portion.
Bioretention	Volume reduction is achieved by surface storage volume, soil storage volume, and infiltration bed volume as described in the fact sheet.
Vegetated Swale	Volume reduction is achieved by surface storage volume (if included in the design through inclusion of check dams) and active infiltration volume during the storm (when infiltration is expressly designed for as a purpose) as described in the fact sheet.

Notes:

A. In using and crediting these BMPs, applicants must meet the review criteria located within the discussion of each BMP provided in Appendix 03702-1.

B. If the LID track is pursued, the volume reduction provided by these BMPs may be recognized/credited towards determining the post-developed runoff rates and volumes for larger events (up to and including the 100-year event). See **Table 03702-8** for extent of runoff reduction recognition allowed for such larger events.

Table 03702-5: Pre-approved Structural BMPs with Permanent Volume Reduction Recognition for Channel Protection as Part of LID Approach

BMP[A]	Runoff Reduction Recognition[B]
Constructed Wetland	The volume of the supplementary extended detention, in lieu of permanent volume reduction, is credited towards meeting Channel Protection Volume requirements so long as only 10% of the maximum stored volume is left in the basin after 36 hours from maximum storage time and no more than 40% from the maximum stored volume is released within the first 12 hours.
Extended Detention Wet/Dry Pond	The volume of the supplementary extended detention, in lieu of permanent volume reduction, is credited towards meeting Channel Protection Volume requirements so long as only 10% of the maximum stored volume is left in the basin after 36 hours from maximum storage time and no more than 40% of the maximum stored volume is released within the first 12 hours.

Notes:

A. In using and crediting these BMPs, applicants must meet the review criteria located within the discussion of each BMP provided in Appendix 03702-1.

B. If the LID track is pursued, the volume reduction provided by these BMPs may be recognized/credited towards determining the post-developed runoff rates and volumes for larger events (up to and including the 100-year event). See **Table 03702-8** for extent of runoff reduction recognition allowed for such larger events.

Table 03702-6:Pre-approved BMPs with Additional, As-needed Extended Detention Runoff Reduction Recognitions for Channel Protection as Part of LID Approach

This checklist is a tool to allow both the regulatory agency and the Developer to reference various LID measures implemented within the development in order to meet the development's Post Construction Stormwater Management requirements.

Project Name: **Engineer:** **Developer:**

Total Site Area: _____sf
Proposed Earth Disturbance Area: _____sf
Existing Impervious Area: _____sf

LID Approach Step	Potential BMPs	√	Total Surface Area (sf) of LID Measure/BMP	Plan Pg # of LID Measure	Pg # of Calculations for LID Measure
1. Minimize Disturbed Areas	Protect Sensitive Areas				
	Protect Riparian Buffers				
	Protect Natural Flow Pathways				
	Minimize Total Disturbed Area				
	Reduce Impervious Surfaces				
	Cluster-Type Development				
2. Restore Disturbed Areas	Minimize Soil Compaction				
	Protect Trees in Disturbed Areas				
	Soil Amendment and/or Restoration				
	Native Revegetation				
	Riparian Buffer Restoration				
3. Minimize Imperviousness	Porous Pavement				
	Vegetated Roof				
4. Determine Volume Control Needed for Channel Protection	N/A (calculation step only)		**N/A**		
5. Provide Distributed Retention/Infiltration Practices	Infiltration Practices*				
	Bio-retention				
	Vegetated Swale				
6. Additional (as-needed) Extended Detention Practices	Constructed Wetland		**N/A**		
	Extended Detention Wet/Dry Pond		**N/A**		
7. Additional (as-needed) Water Quality BMPs	Pre-approved BMPs noted in Table 8-1 for conventional method		**N/A**		
Additional Flood Peak Control (2yr-100yr)	Detention Pond (wet/dry/underground)		**N/A**		

Total Surface Area of LID Measures _____ sf

Proposed Final Impervious Surface Area _____ sf

Percent of Total Site Area Covered by LID _____%

Note: Not all LID measures are necessary or appropriate for every site. It is imperative that proper site assessments and due diligence is completed by the Developer and/or Engineer prior to design.

*: Infiltration Practices include: Infiltration Basins, Subsurface Infiltration Beds or Trenches, and Dry Wells

Table 03702-7: LID Approach Summary Checklist

LID BMP GROUP	DESCRIPTION	POTENTIAL BMPS	RUNOFF REDUCTION RECOGNITION FOR POST-CONSTRUCTION WATER QUALITY CALCULATIONS		RUNOFF REDUCTION RECOGNITION FOR WATER QUANTITY (DETENTION AND STORM DRAIN) CALCULATIONS
			WATER QUALITY VOLUME	CHANEL PROTECTION VOLUME	
1	Minimize Disturbed Areas	• Protect Sensitive Areas • Protect Riparian Buffers • Minimize Total Disturbed Area • Protect Natural Flow Pathways • Reduce Impervious Surfaces • Cluster-Type Development	Full recognition through allowing to use "disturbed surface area" only for all calculations	Full recognition through allowing to use "disturbed surface area" only for all calculations	Full recognition through allowing CN for the undisturbed, protected area to be calculated based on pre-developed underlying soil types
2	Restore Disturbed Areas	• Minimize Soil Compaction • Protection of Existing Trees within disturbed areas (part of Minimize Total Disturbed Area) • Soil Amendment and Restoration • Native Revegetation • Riparian Buffer Restoration	Full recognition through allowing CN for the restored/protected area to be calculated based on pre-developed underlying soil types	Full recognition through allowing CN for the restored/protected area to be calculated based on pre-developed underlying soil types	Full recognition through allowing CN for the restored/protected area to be calculated based on pre-developed underlying soil types
3	Minimize Imperviousness	• Porous Pavement	Full recognition of perviousness through allowing CN for the application area to be calculated based on a pre-set value (74 instead of 98) AND full recognition of the stored volume (if provided for in the design) and WQ treatment, if designed as a true infiltration practice (no underdrain/ or extended 24-48 hrs release)	Partial (weighted) recognition of perviousness through allowing CN for the application area to be calculated based on a pre-set value (87 instead of 98) AND full recognition of the stored volume (if provided for in the design), if designed as a true infiltration practice (no underdrain/ or extended 24-48 hrs release)	Partial (weighted) recognition of perviousness through allowing CN for the application area to be calculated based on pre-set values (89 for 10-year and 90 for 100-year calculations instead of using 98) and full recognition of the stored volume (if provided for in the design), on a case by case basis, treated as an underground detention
		• Vegetated Roof	Full recognition of perviousness through allowing CN for the application area to be calculated based on a pre-set value (74 instead of 98) AND full recognition of the stored volume (if provided for in the design) and/or WQ treatment if designed for	Partial (weighted) recognition of perviousness through allowing CN for the application area to be calculated based on a pre-set value (87 instead of 98)	Partial (weighted) recognition of perviousness through allowing CN for the application area to be calculated based on a pre-set value 89 for 10-year and 90 for 100-year calculations instead of using 98)
4	Provide Distributed Infiltration Practices (or Filtration Practices, if underdrains have to be provided) in Common Areas	• Infiltration Practices (Infiltration Basin, Subsurface Infiltration Bed, Infiltration Trench, and Dry Well) • Bioretention • Vegetated Swale	Full recognition of perviousness through allowing CN for the application area to be calculated based on cover type and underlying soil AND full recognition of the retained volume (if provided for in the design) and/or WQ treatment if designed for	Full recognition of retained volume if designed as true infiltration practice (on appropriate soil and no underdrain/ or extended 24-48 hrs release)	Limited recognition of retained volume (up to the Channel Protection Volume) if designed as true infiltration practice (on appropriate soil and no underdrain/ or extended 24-48 hrs release)
5	Provide, as-needed, Extended Detention Practices in Common Areas	• Constructed Wetland • Extended Detention Wet/Dry Pond	full recognition of the stored volume (with extended 24-48 hrs release) and/or WQ treatment if designed for	Full Recognition of stored volume (with extended 24-48 hrs release)	Full Recognition of stored volume (with extended 24-48 hrs release)
6	Provide, As needed, Additional Water Quality BMPs	• Pre-approved BMPs noted in Table 702-1 for conventional method	Full recognition of WQ treatment	N/A	N/A

Table 03702-8: Summary of Runoff Reduction Recognitions for Pre-Approved BMPS Used in the LID Approach

Stormwater Hot Spots	Minimum Pre-Treatment Options
Vehicle Maintenance and Repair Facilities	A, E, F, G
Vehicle Fueling Stations	A, D, G
Drive-through Restaurants, Pharmacies, Convenience Stores	B, C, D, I, K
Outdoor Chemical Mixing or Handling	G, H
Outdoor Storage of Liquids	G
Commercial Nursery Operations	I, J, L
Other Uses or Activities Designated by Appropriate Authority	As Required

Table 03702-9: Pre-Treatment options for Stormwater Hot Spots

Minimum Pre-Treatment Options	
A	Oil/Water Separators / Hydrodynamic Separators
B	Sediment Traps/Catch Basin Sumps
C	Trash/Debris Collectors in Catch Basins
D	Water Quality Inserts for Inlets
E	Use of Drip Pans and/or Dry Sweep Material under Vehicles/Equipment
F	Use of Absorbent Devices to Reduce Liquid Releases
G	Spill Prevention and Response Program
H	Diversion of Stormwater away from Potential Contamination Areas
I	Vegetated Swales/Filter Strips
J	Constructed Wetlands
K	Stormwater Filters (Sand, Peat, Compost, etc.)
L	Stormwater Collection and Reuse (especially for irrigation)
M	BMPs that are a part of a Stormwater Pollution Prevention Plan (SWPPP) under a NPDES Permit

Table 03702-10: Minimum Pre-Treatment Options

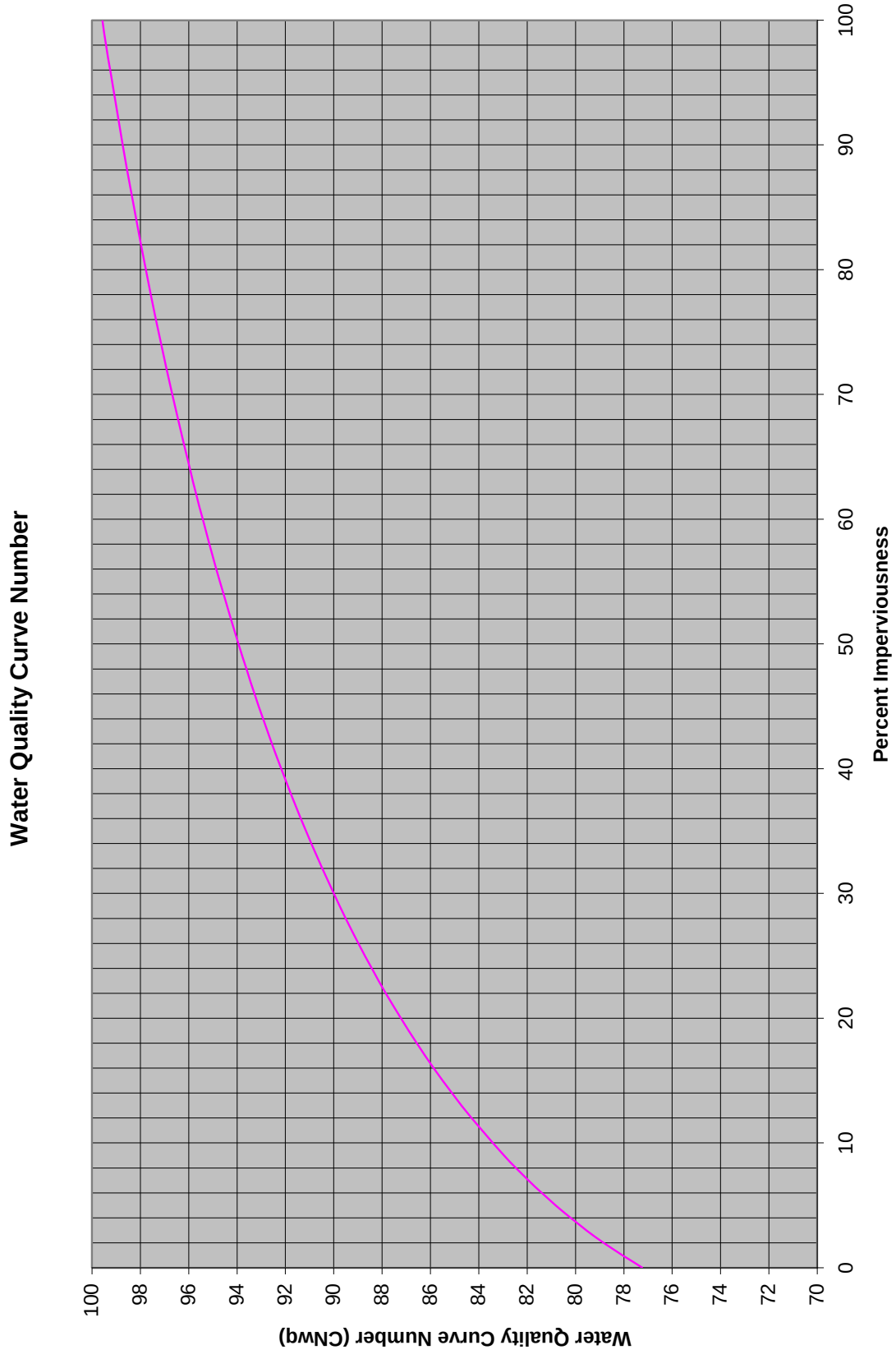

Exhibit 03702-1: Curve Number Calculation for Water Quality Storm Event